Attachment A

**Speech Notes from Thomas A. Baughman, Ph.D.,
with the Illinois Department of Public Health
on Indoor Air Quality and Elemental Mercury**

Chemical Spills and the Indoor Environment: Elemental Mercury

July 12, 2000

Thomas A. Baughman, Ph.D.
Environmental Toxicologist
Illinois Department of Public Health
West Chicago Regional Office
245 W. Roosevelt Rd., Bldg. 5
West Chicago, IL 60185
630-293-6800
E-Mail: tbaughma@idph.state.il.us

1. My name is Tom Baughman, and I am in the Environmental Toxicology Section of the West Chicago Regional Office of the Illinois Department of Public Health (IDPH).
    a. Along with indoor air quality, I deal with many other uses, including:
        1. Health assessments of hazardous waste sites.
        2. Writing educational bulletins.
        3. And miscellaneous chemical spills and other issues, such as homes affected by leaking underground storage tanks at gasoline stations, insecticide misapplications, and mercury spills.
        4. I also get some interesting calls. I'll share two of my favorites:
            a. A guy called and said that he had DDT in the carrots that he had just bought at the grocery store. I asked him how he knew, and he said that he could taste it. I asked him what DDT tasted like, and he said, "You know !#@$! well what DDT tastes like," and slammed down the phone. Several years later, a guy called one of our milk inspectors and said that he had DDT in the milk that he had just bought. Our inspector asked him how he knew, and he replied that he could taste it. Our inspector asked what DDT tasted like, and he replied, "You know !#@$! well what DDT tastes like," and slammed down the phone. The good news is that he hasn't died of DDT poisoning yet.
            b. Another guy called me because his daughter had bought a computer. He had heard about computer viruses, and he wanted to know if he could get a virus from the computer and get sick.
2. Before I begin, I want to say that when our department first started getting involved in residential mercury spills around 10 years ago, USEPA assisted by hiring contractors to examine the extent of contamination and perform the cleanup. Shortly thereafter, we were evidently mistakenly told by USEPA staff that USEPA no longer provided these services. Consequently, for many years, we guided homeowners on how they could clean up a spill. Most of them could not afford a professional firm. Just last year, I learned

that we had been misinformed, and that USEPA still assisted with residential cleanups. I am now basing the need to involve USEPA on the ability of the property owner to pay for the cleanup. If they are a doctor's office or a hospital, they can afford a contractor, but a homeowner or a nonprofit clinic often lacks the financial resources. In any case, the intervening years gave us many experiences with mercury spills, including over 20 of my own, which I now can share with you.

3. Today, I will talk about elemental mercury spills indoors. To begin, I will give you a brief description of what can occur after mercury is spilled in a home. Then, I will discuss how mercury spills occur and our department gets involved in mercury spills. Then, I will discuss the health effects of mercury, regulatory standards and guidelines for mercury exposure, how to handle and clean up a mercury spill, what USEPA is trying to reduce mercury use in an effort to reduce mercury problems in the first place, what we can do to minimize problems with mercury, and how to properly get rid of mercury.
4. To begin, I have a case study from the literature as an example of how serious a small mercury spill can be in a home.
    a. Early in the summer, a boy spilled less than one fluid ounce volume of mercury in a bedroom of his home. Later that summer, his sister was admitted to the hospital because she had difficulty walking. Doctors diagnosed her with a viral illness and subsequently sent her home. Three weeks later, she could no longer walk and was readmitted to the hospital. Her sister subsequently developed similar symptoms. This time, doctors properly diagnosed their condition as mercury poisoning. All this was from less than one fluid ounce volume, or less than half a teaspoon of mercury.
    b. Consequently, a small amount of mercury spilled in a home can cause quite serious symptoms. Also, doctors frequently mis diagnose mercury poisoning.
    c. So, how do mercury spills occur and how do we find out about them? What are the symptoms of mercury poisoning? How do we handle a mercury spill, and how do we clean up a mercury spill? What is USEPA doing to try to reduce mercury use in an effort to reduce mercury spills in the first place and to reduce general mercury pollution in the environment? These are the questions that I hope to answer for you.
5. So, how do mercury spills occur and how does our department get involved in them?
    a. People often keep jars of mercury in their homes because they think that mercury is worth money, like liquid silver. In reality, mercury is nearly worthless, but the cleanup cost after a large spill easily can exceed the cost of a home.
    b. Often, children find a jar of mercury and play with it.
    c. Other times, jars stored for years fall off shelves and break. Sometimes, people had forgotten that the mercury was there.
    d. Schools often have jars with pounds of mercury (and other hazardous chemicals) kept for many years, and the school administration often is unaware of its presence.
        1. In one school, a seventh grade student found a jar with about 4 pounds of mercury in an unlocked cabinet. He threw beads of mercury in two

hallways and passed mercury to friends. Besides the school, I checked over a dozen homes of kids who played with the mercury. Fortunately, only one home had appreciable contamination.

e. Other common causes of large mercury spills are broken sphygmomanometers (blood pressure devices) or other medical instruments.

f. Old barometers and manometers (measure pressure or water levels) also may contain mercury. Many of these contain a pound or more of mercury. I once even had a case with a leaking manometer that held about 75 pounds of mercury.

g. Teenagers trespassing at abandoned industrial sites have found mercury and contaminated their homes and schools.

h. Some folk remedies for cholic contain mercury.

i. Some Hispanic and Caribbean religious practices use mercury for everything from good luck to warding off evil spirits.

   1. Cultures associated with these practices include:
      a. Esperitismo, a spiritual belief system native to Puerto Rico,
      b. Santerina, a Cuban-based religion that venerates both African deities and Catholic saints, and
      c. Voodoo.
   2. In folk medicine practices, mercury, sold under the name Azogue in Hispanic stores called botanicas, has been administered orally to treat constipation, colic, or stomach ache.
   3. Other reasons for taking mercury include the treatment of alcoholism, and, ironically, to treat nervousness. Using mercury to treat nervousness is kind of like using a chain saw to stop bleeding.
   4. In the Hispanic community, the rate of use of mercury for folk medicine or religious purposes is uncertain.
   5. In Chicago, a study found that of 16 botanicas, all of them sold mercury. Only four of these botanicas included a warning label with the mercury, but in all cases, the warning label was inadequate according to Consumer Product Safety Commission regulations.
   6. In New York City, a study found that more than 90% of the visited Botanicas sold capsules of mercury daily. Many buyers carried mercury in sealed pouches, but nearly one third of buyers sprinkled mercury in their homes.
   7. Methods for using mercury in religious practices include:
      a. Carrying mercury in an amulet or purse,
      b. Burning mercury in a candle,
      c. Mixing it with perfume,
      d. Putting it in a glass of water kept under the bed,
      e. Sprinkling it around a crib or bed of a small child,
      f. Sprinkling it in or around a car,
      g. Swallowing it in a capsule or drink, or
      h. Mixing it with their bath or cleaning water.

8. The USEPA modeled air concentrations expected in a typical room if a homeowner sprinkled mercury around a crib or burned it in a candle.
    a. For mercury sprinkled around a crib, USEPA assumed that 9 grams of Hg was applied to the floor around a crib every 3 days for 2 years. According to the model, the concentration would rise to a maximum concentration of 0.39 mg/m^3, which may persist for 16 months. They assumed that the concentration would decline to zero 40 months after mercury applications ended. Their estimated average concentration over the 5.5 year period was 0.26 mg/m^3. These concentrations are very high and within the range that can cause very serious neurological and kidney damage in adults, let alone in children.
    b. For the candle burning scenario, the complete volatilization of mercury within one minute would produce extremely high peak levels in an average-sized room, 2.37 mg/m^3. The average concentration over time would be 0.046 mg/m^3, which is within the range that has produced neurological effects in children and adults.
    c. Clearly, the ritualistic use of mercury can produce airborne levels that may result in serious poisoning. Unfortunately, the neurological effects of mercury can be permanent, and mercury poisoning often is mis diagnosed by doctors.
9. The rate of mercury use in the Hispanic community is uncertain, but a door-to-door survey of 79 people by the Chicago Department of Public Health found that 15, or 19% of the people, had used mercury for folk remedies or ritualistic practices.
    a. Of particular concern was that half of the ritualistic mercury users had children. In addition, most of the users were women, increasing the likelihood of fetal exposure.
    b. Most of the mercury users had little formal education, with just over half of them having no more than a primary education.
10. One ironic twist is that the religious leaders often have herbs that they would normally recommend, but they recommend mercury instead, because the herbs are harder to get in the U.S.
11. Our department got a USEPA grant and tried studying homes where people have used mercury in these religious practices. However, we couldn't recruit anyone willing to admit that they had used mercury.

g. Recently, some skin-lightening creams have been implicated in mercury poisoning.
    1. In these cases, the creams contain mercuric chloride, which penetrates the skin more easily than elemental mercury.

2. Creams from Mexico (especially), southeastern Asia, and Arabian countries have been found with mercury, with the Mexican creams the most commonly implicated in this country.

h. So, to recap sources of mercury spills, they include small sources like a broken thermometer and large sources, like accidental spills from stored jars in homes, children finding mercury and playing with the neat stuff, broken medical devices, and old barometers and manometers. Ritualistic use of mercury also may cause exposure. Skin-lightening creams may result in exposure to mercuric chloride.

i. So, how do we get involved in mercury spills?

1. Most of the time, we get calls about spills soon after they occur, and before any symptoms develop. Often, we get referrals from the Poison Control Center.
2. Unfortunately, sometimes people are unaware of the hazards of mercury or unaware of what their children did. In these cases, we often do not find out about the situation until serious poisoning occurs. In one of these cases, a child almost died.
3. Our department has been involved in many mercury spills, ranging from a broken thermometer to large spills of up to 26 pounds. Twenty-six pounds sounds like a lot, but because mercury is so heavy, that is about one quart of volume.

6. Now that we have discussed how mercury spills occur and how we get involved in them, I will discuss the health effects of mercury.

a. The primary route of concern for elemental mercury is inhalation, because absorption is rapid after inhalation.

b. However, absorption of elemental mercury after ingestion is low.

c. Some elemental mercury can penetrate the skin, especially if cuts are present. Ionic and organic forms of mercury more easily penetrate the skin.

d. Because the body slowly eliminates mercury with a half-life of around a month, cumulative exposure is very important.

e. At the temperatures normally encountered indoors, airborne concentrations usually are not high enough to produce symptoms after short-term exposure. Generally, exposure for a month or more is needed to produce symptoms.

1. An exception is if the mercury is heated, which increases evaporation and, hence, airborne levels. In Michigan, four adults in a home decided to try to melt down silver fillings on the stove to recover the silver. After doing this smelting for one day, all four people came down with severe neurologic symptoms. In spite of chelation to try to get the mercury out of their bodies, all four of them died within 11 to 24 days of exposure. It's very hard to get mercury out of the body, so avoiding exposure is the better alternative. In this home smelting case, the home was so contaminated that all remediation efforts failed, and the home had to be demolished. This was from a one day smelting operation on the home stove.

f. Long-term exposure to low levels of mercury can permanently damage the brain and kidneys, and decrease fetal survival.

g. Neurological symptoms of chronic mercury exposure include decreased nerve conduction, decreased psychomotor skills (e.g., finger tapping and hand-eye coordination), irritability, poor concentration, shyness, tremors (initially affecting the hands, and sometimes spreading to other parts of the body), and short-term memory deficits.
   1. The motor system disturbances may be reversible after exposure ends, but cognitive impairments, primarily memory deficits, may be permanent.
   2. Other symptoms may include abdominal cramps, nausea, diarrhea, eye irritation, skin rashes (called acrodynia), and weight loss. We had one case where a child lost his spleen, but that was unusual.

h. Unfortunately, cases of mercury poisoning often are mis diagnosed. Besides the case already described, doctors mistook another case of mercury poisoning for rheumatic fever. Then, they mistook it for psychotic depression before correctly diagnosing it as mercury poisoning. The worst part about being mis diagnosed is that generally, the patient returns home, where their condition worsens because of re exposure. Remember, the body eliminates mercury very slowly, with a half life of about a month. Consequently, minimization of exposure is very important during the recovery period.

i. Children are more sensitive to mercury than adults. Four factors contributing to this include:
   1. Mercury vapors are heavy and settle, making concentrations higher at floor level, where young children play;
   2. The blood-brain barrier of children is less able to keep mercury out of the brain;
   3. The respiration rate of children is higher than adults, so children inhale more mercury than adults at a given concentration; and
   4. The brains of children are still developing.

j. So, to recap the health concerns, the primary concern of elemental mercury is inhalation. Mercury can cause serious neurological and kidney damage, and children are more sensitive than adults. At room temperature, chronic exposure of a month or more generally is needed to produce symptoms; however, if mercury is heated, symptoms may occur rapidly. Unfortunately, doctors often mis diagnose mercury poisoning, and the patient becomes worse after returning to a contaminated environment. The body slowly eliminates mercury with a half-life of about a month, so minimizing mercury exposure during the recovery period is very important.

7. So, now that we know the neurological, kidney, and other problems that mercury can cause, what regulatory standards and advisories exist to protect people from mercury?

   a. For elemental mercury, the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) recommended residential limit for continual habitation by children is 0.0003 milligrams per cubic meter (mg/m^3). This is a

recommendation and not an enforceable limit. One study associated chronic exposure of 0.010 to 0.040 mg/m^3 with neurological symptoms in children.

b. The occupational limit of the U.S. Occupational Safety Health Administration (OSHA) was 0.050 mg/m^3 as a time-weighted average for eight hours, five days per week, but this standard was vacated by a 1989 court decision which vacated all 1987 OSHA standards. This rolled back the OSHA airborne mercury standard to its 1973 concentration, 0.1 mg/m^3. This old OSHA standard was based on a 1968 recommendation by the American Conference of Governmental and Industrial Hygienists (ACGIH). OSHA standards are enforceable, but OSHA also can enforce ACGIH TWAs under their "General Duty Clause."

c. The ACGIH currently (and since 1994) recommends a maximum mercury concentration of 0.025 mg/m^3 as a time-weighted average (TWA) for eight hours per day, five days per week.

d. One study associated chronic exposure to levels only slightly higher than the ACGIH TWA, 0.026 mg/m^3, with irregular gait and tremor in workers. However, conflicting information exists concerning thresholds for neurological effects, with some studies not reporting neurological effects at slightly higher concentrations.

e. Because children are more susceptible to mercury than adults, occupational standards definitely do not apply to children.

f. Studies have not examined human fetal exposure to elemental mercury, but mercury readily crosses the placenta.

g. Consequently, the OSHA standard and the ACGIH TWA may not adequately protect pregnant women and, especially, their unborn children, from elemental mercury.

h. The Imminently Dangerous to Life or Health (IDLH) level for elemental mercury is 10 mg/m^3 for 30 minute exposure, but substantially lower levels can cause death after chronic exposure.

i. Above all, it is better to err on the side of caution when dealing with a substance as dangerous at low levels as mercury.

8. Next, I will discuss how to handle a mercury spill once it occurs.

a. Part of how we respond depends on the size of the spill. A broken thermometer or broken thermostat is a small spill, and anything larger is a large spill.

b. After a thermometer has been broken, we have never detected elevated airborne mercury concentrations.

1. In theory, if you evaporate all the mercury in a fever thermometer, about one gram, the resulting airborne concentration would be very high. However, that normally does not occur. Most of the mercury is in the bulb, and a dropped thermometer usually breaks with the bulb still intact. The part that usually breaks has a thin capillary tube, which contains very little mercury. Consequently, usually, little mercury from a broken thermometer actually spills.

2. Also, mercury evaporates slowly at room temperature. It would be of greater concern if someone broke a thermometer over a hot surface.

3. In one case, a mother accidently dropped a thermometer down a heating duct of her home. The heating duct was one about inch wide, so she could not retrieve the thermometer. We were concerned that the elevated temperature in the duct might have increased the evaporation of the mercury, resulting in increased airborne concentrations. I checked the home while the furnace was operating and did not detect elevated mercury concentrations.
4. So, given this, how do we handle a broken thermometer?
5. We no longer bother going out to measure airborne concentrations. Instead, we tell people over the phone how to clean up their little spill.
6. We also tell people not to panic. For some reason, people usually are more worried after breaking a thermometer than after spilling pounds of mercury.
7. Free mercury droplets can be picked up with masking tape or a medicine dropper.
8. After picking up visible mercury droplets, ventilate the room and avoid vacuuming for one to two weeks. A home vacuum cleaner or shop vac will aerosolize the mercury, increasing airborne concentrations and spreading the contamination. The vacuum cleaner also will become permanently contaminated, requiring its disposal.
9. So, basically, the solution is to pick up the mercury, ventilate, and avoid vacuuming.

c. Compared with a broken thermometer, however, a large mercury spill is a totally different animal. Serious poisoning, particularly of children, may occur.

d. After a large spill, a family should leave their home or apartment, particularly if they have small children or someone is pregnant. Leaving is especially important if someone has mercury poisoning symptoms or elevated blood or urine mercury concentrations.

e. Getting a family to leave often is a challenge, as many people who keep jars with pounds of mercury don't see mercury as hazardous. In fact, the homeowner of my largest residential spill, 26 pounds, wanted proof of hazardous levels before getting his family, with two small children, out of the home. Needless to say, I didn't have any problem giving him the proof.

f. After a large mercury spill, the family should be referred to an occupational physician familiar with mercury poisoning.

g. Blood or urine mercury levels, particularly of children, should be measured. Twenty-four hour urine mercury levels are considered the most accurate biomarker of mercury exposure.

h. After a mercury spill, reducing the spread of contamination is very important. The extent and cost of a mercury cleanup often depend more on the spread of contamination than on the actual amount of mercury spilled.
   1. To be conservative, treat the carpeting as contaminated.
   2. To reduce tracking, limit the number of people entering a home.

3. To avoid tracking by cleanup people, investigators, and residents, place pieces of plastic on the floor, such as plastic garbage bags or plastic runners, and step only on them.
4. Use rubber disposable booties to avoid contaminated shoes. I once had a case where a local governmental official was meeting me at a residential mercury spill. I took along disposable booties for him and told him that I would. However, when I arrived, I was surprised to find him already inside the home. His shoes were highly contaminated and needed to be discarded. I had another case where the same thing occurred, but the contamination was less severe, and we managed to salvage the shoes using a mercury spill kit. I will describe these kits later.

i. After a mercury spill, ventilate the home, preferably by placing the spill room under negative pressure with an exhaust fan.

j. Never assume that a person, especially a child, who spilled mercury is uncontaminated.
1. In one case, a father assumed this; however, we later found that the bedding of one of his five children and all the carpeting in their home were contaminated. This was true although:
a. The one pound spill was in a second floor bedroom;
b. The father put plastic on the floor of the spill room to prevent tracking;
c. He changed his shoes upon leaving;
d. He kept the door to the room closed, and
e. The family left the home within two hours.
f. Furthermore, the lowermost of the three layers of basement carpeting was the most contaminated. Mercury is heavy, and it went as far down as it could.
g. The father did almost everything right, but he made one mistake. He assumed that his kids didn't have any mercury on them.
h. Mercury can spread very quickly by tracking. Basically, within two hours, the kids had tracked the mercury everywhere.
i. The source of the pound of mercury was a medical dilator that was being used on their one child after surgery. One of the kids decided to twirl it around like a sword, breaking it in the process, splashing the carpeting, a crib, and the wall.
j. The family ultimately lost about 80% of the personal property in their home. If the kids had not tracked the mercury, the cleanup just would have affected one room. The cleanup costs would have been much lower, the property loss would have been minimal, and the family of seven would have been able to move back home much sooner.

k. This is why the extent and cost of a cleanup often depends more on the spread of contamination than on the actual amount of mercury spilled.

l. Consequently, minimizing the spread of contamination is very, very important.

m. Another big take home lesson is to never assume that a kid who played with mercury is uncontaminated.

2. A person who spills mercury should immediately remove their clothing and shoes and place them in a plastic bag for future testing.

3. They then should shower and put on clean clothes.

4. Do not wash contaminated clothing with laundry, for this may permanently contaminate the washer, requiring its disposal.

5. We have never observed mercury contamination in a dryer, probably because the heat evaporates the mercury.

6. Remove pets from a home to reduce tracking, and wash them thoroughly.

k. Never, never, never use a conventional vacuum cleaner to clean up mercury. This will disperse micro droplets of mercury, and the droplets will settle everywhere, increasing the extent of contamination. A vacuum cleaner also will aerosolize the mercury, increasing airborne concentrations. The vacuum cleaner will be permanently contaminated and will need to be discarded.

1. For example, in one case, a homeowner kept a jar with13 pounds of mercury on a kitchen pantry shelf, the logical place. He kept the mercury because he thought it was worth a lot of money. One day, the shelf broke, dumping all its contents on the floor. Of course, the jar of mercury was the only thing that broke. The homeowner called the fire department. Unfortunately, rather than calling the HAZMAT team, the fire department vacuumed the mercury. Removing the kitchen carpeting and cleaning the underlying floor failed to reduce airborne mercury concentrations to acceptable levels. The subsequent removal of the particle board flooring also failed to alleviate the problem. The mercury aerosolized by the vacuum cleaner had soaked into the ceiling, walls, and cabinets of the kitchen. The cleanup ultimately required taking the kitchen down to the studs. Fortunately, two closed doors protected the rest of the home from serious contamination. Otherwise, the cleanup cost easily could have exceeded the cost of the home.

2. As I said before, never, never, never use a conventional vacuum cleaner or shop vac to clean up mercury.

i. OK, now we know how to minimize the spread of contamination and ventilate, and to get people out of the contaminated building. We also know not to use a conventional vacuum cleaner or shop vac. Now, the next step in handling a mercury spill is to determine how bad the contamination is. So, how do we measure the mercury to determine the amount and extent of contamination?

1. A Jerome Mercury Vapor Analyzer, Arizona Instrument, measures mercury concentrations, and it provides a rapid (12 second) direct readout.
2. A Jerome meter has a sensitivity of 0.002 mg/m^3, so it cannot reach the ATSDR guideline of 0.0003 mg/m^3. A Jerome meter is a screening device sensitive enough to locate hot spots and guide a cleanup.
3. Because the accuracy of a Jerome meter is 0.003 mg/m^3, I take multiple readings, especially if the measured concentration is below 0.010 mg/m^3. This is to minimize error. If I get changing readings, I also make multiple measurements to make sure that the instrument is operating properly. One thing I have noticed is about 5 minutes before the Jerome meter gives the "low battery" signal, it starts giving erratic readings.
4. I also periodically use a filter, called the Zero Mercury Filter, that fits on the inlet of the Jerome meter and removes mercury from the incoming airstream. Using it should give me zero as a reading. I use it for the initial zeroing. Then, I also use it later to establish that the zero is still zero, and that any small variations are real and are not caused by instrument drift. Instrument drift is not uncommon with a Jerome meter.
5. Temperature fluctuations also may alter readings, often unpredictably. Again, using the mercury filter on the inlet can help answer what the machine is really doing.
6. Ammonia from household cleaners, tobacco smoke, or cat litter can give false positive readings on a Jerome meter, and even quite high false positive readings.
7. Because mercury vapors are heavy, concentrations are highest at floor level. Consequently, make measurements at floor level. I also take some breathing zone measurements to determine the levels of exposure for bigger people.
8. Because mercury volatilizes slowly, for mercury measurements to be meaningful, windows must be closed at least overnight and preferably for 24 hours before testing.
9. In one of my cases, the homeowner accidently left one window open, and I detected elevated airborne mercury concentrations only at the spill site.
10. They then closed the last window. The next day, airborne mercury concentrations throughout their home were within the range where neurological effects have occurred in children after exposure of a month or more. A little ventilation can make a huge difference in mercury concentrations.

j. After determining the extent of contamination with a Jerome meter, the next step is to clean up the spill.
   1. After initial airborne mercury measurements, the cleanup should start with the spill room and any "hot spots" identified with the Jerome meter.

2. Do not clean the whole building just because airborne mercury concentrations progressively decline away from the spill room. Until the spill room is cleaned, it usually is impossible to know whether the airborne mercury away from the spill room is from tracked contamination or from air movement within the building.
3. A prompt cleanup is important, because mercury vapors soak into building components and contents with time, making the cleanup more difficult.
4. Seal air vents in the spill room with plastic and tape to prevent contamination of the ventilation system.
5. Contaminated hard surfaces, such as linoleum, hardwood floors with a good finish, metal, plastic, or tile usually are cleaned rather easily.
6. However, contaminated porous items, such as carpeting, clothing, fiberboard, unfinished wood, and upholstered furniture generally cannot be decontaminated and must be discarded.
7. Mercury can be cleaned up with a mercury spill kit (sulfur and zinc), which amalgamates mercury into a form that does not volatilize readily. Spread the contents of a mercury cleanup kit on the floor and work it into cracks with a broom. Clean up the residue with a broom and dustpan, followed by trisodium phosphate detergent and water. Sulfur and zinc react rapidly with mercury, so they do not require extended contact time.
8. Money permitting, hazardous waste cleanup firms are the best for handling large mercury spills. Most of these firms use nitric acid to dissolve mercury, followed by trisodium phosphate and a water rinse.
9. Do not use acid and sulfur together, or lethal concentrations of highly toxic hydrogen sulfide fumes are likely.
10. Professional cleanup firms also have special vacuums with mercury filters that help pick up mercury, but these mercury vacuums generally cannot finish the cleanup alone. An acid wash or mercury spill kit usually is needed.
11. After the cleanup, ventilate the building for one to two weeks. Using electric space heaters coupled with ventilation will accelerate mercury dissipation.
12. Then, close the windows for 24 hours (or at least overnight) and re test the airborne mercury levels with a Jerome meter. If the Jerome meter gives zero or fluctuating low readings barely above zero, proceed with clearance sampling. For clearance sampling, use portable air pumps and sampling tubes. I've used Hopcalite tubes, which I understand have been discontinued. I still have a good supply of Hopcalite tubes and have not tried the replacement tubes. Clearance sampling requires laboratory analysis.
13. Because of tracking, cleaning the spill room alone usually does not reduce airborne mercury to acceptable levels. In over 20 mercury spills, I've only

seen contamination restricted to the spill room three times. Tracking usually occurs. If the cleanup of the spill room fails to reduce airborne mercury to acceptable levels, then all floors of a home need to be cleaned.

14. In the one pound mercury spill where the 5 kids tracked mercury everywhere within two hours, cleaning all floors of the home failed to reduce mercury concentrations to acceptable levels.
15. The homeowner placed all house contents in plastic bags in the back yard.
16. We then used a Jerome meter to test the bagged contents for contamination. Most of the house contents were contaminated. Mercury traveled very fast in two hours, although some vapor contamination also may have occurred. As I'll discuss later, mercury vapors tend to soak into porous items and contaminate them with time.
17. Rather than immediately discard any contaminated items, we decided to leave them outside for one to two months over the summer. We had nothing to loose, and we wanted to see if airing out the items might eliminate the contamination, minimizing property loss. Property loss is very stressful to household members.
18. In the first case above where I tested bagged items, bagged items initially giving readings of <0.01 mg/m^3 with the Jerome meter usually declined to non detectable within a month.
19. Bagged items giving readings between 0.01 and 0.02 mg/m^3 usually became non detectable for only hard-surfaced items. Porous items often remained contaminated.
20. Bagged items giving readings of more than 0.02 mg/m^3 usually remained contaminated.
21. Winter weather can be a problem with this type of testing, because mercury volatilizes much slower at lower temperatures. Basically, you need at least moderate temperatures.
22. Alternatively, in cold weather, I have tested bagged items indoors. Then, I subtract the ambient mercury concentration in the room to determine what the airborne mercury concentration in the bag would be if it were outside and not in a contaminated atmosphere.
23. This testing of bagged items is a very sensitive method for detecting contamination. However, the relationship between these readings and the amount of mercury that people may track into a home is unknown. The airborne concentration that a contaminated item may produce if brought into a home also is unknown.
    a. In one example, students at a school played with mercury. The shoes of one student gave a reading of 0.016 mg/m^3 when placed in a plastic bag. Previously, when these shoes were in a room of their home, our Jerome meter did not detect any mercury. This was true even when I held the meter one inch from the shoes.

22. I recommend the airing out of contaminated items to minimize property loss, which is very stressful to homeowners.

k. As I said before, mercury vapors tend to soak into porous building components and building contents with time. Liquid mercury also tends to soak into contacted building components with time. Consequently, if a spill is old, it is likely that the mercury has soaked deeply into building components. Because mercury evaporates slowly, elevated airborne mercury levels may persist for years after a large spill.

1. In two of my three cases involving old spills in basements, cleaning followed by ventilation did not reduce airborne mercury concentrations to the ATSDR guideline. Upstairs, airborne concentrations did not exceed the ATSDR guideline, and use of the basements was infrequent. Consequently, the homeowners decided to live with elevated basement mercury concentrations rather than rip out the concrete floors of their basements. Ripping out the basement floors also may have resulted in the spread of dust and contamination, requiring containment during remediation.

m. So, how much remediation is needed before we can let ventilation take care of the rest of the mercury? After a major mercury spill, cleanup to the ATSDR guideline is very hard to achieve initially.

1. It generally involves a major loss of personal property and extensive remediation.
2. A Jerome meter cannot detect such a low concentration.
3. Reaching the ATSDR guideline requires sampling with air pumps and laboratory analysis.
4. Consequently, an initial cleanup to the ATSDR guideline involves having to wait for laboratory results and involves a long period before the family can return to their home.
5. Basically, once a cleanup reduces airborne concentrations to less than 0.010 mg/m^3, ventilation usually can take care of the rest, with substantially lower cleanup costs and much less loss of personal property.
6. For many reasons, our department now is using the ATSDR level as an ultimate goal of remediation, but not as a general requirement for re occupancy.
    a. Studies have not reported adverse health effects in children at airborne mercury concentrations below 0.010 mg/m^3. However, data are limited, so we should not view this as a cutoff level.
    b. The removal and testing of house contents, having to throw out contaminated items, and displacement from a home are very stressful to homeowners. In one case, the homeowners lost about 80 percent of the contents of their home, and this left them in a state of shock.

c. People who keep jars of mercury in a home often lack the money for an extended hotel stay and extensive remediation.

d. Many homeowners give up trying to achieve the ATSDR guideline once they learn that levels below 0.01 mg/m^3 have not been associated with adverse health effects, and that the ATSDR guideline has a built-in safety factor.

e. In Hamilton, Ontario, many homes and other buildings were contaminated after children found and played with a large amount of mercury that they found in an abandoned factory. Airborne mercury levels in homes ranged from 0.004 to 0.07 mg/m^3. Homes were cleaned to below 0.01 mg/m^3, which was considered protective of public health. They judged that once they removed the major contamination, ventilation would take care of the rest. Our experience with bagged items and homes with low levels of contamination supports this hypothesis.

f. Ventilation by cracking windows greatly reduces airborne mercury concentrations in a building.

    a. In one case, I was testing bagged shoes for mercury contamination in a conference room of a school.

        1. Initially, I got zeroes for background. Then, I started getting background readings around 0.008 mg/m^3 from the 50 or so bagged shoes piled in front of me.
        2. Opening a window on the other side of the room rapidly reduced airborne mercury to non detectable concentrations.

    b. In two of our cases, people decided against our advice and continued to live in contaminated homes.

    c. In one of these cases, the average mercury concentration was under 0.010mg/m^3 (range 0.004 mg/m^3 to 0.013 mg/m^3).

        1. These concentrations were with the windows closed, but the family ventilated, which reduced the airborne concentrations below the detection limit of our Jerome meter.
        2. Urine mercury concentrations of all family members (including an 11-month-old child) remained non detectable, so overexposure did not occur.

    d. In the other case, a family discovered an old 4 pound mercury spill in their basement during renovations.

1. Airborne concentrations in the basement were very high, and with windows closed upstairs, concentrations ranged up to 0.011 mg/m^3.
2. After widows were open for about an hour, airborne mercury concentrations in the living area ranged from non-detectable to 0.007 mg/m^3, with quite a few readings non-detectable.
3. Concentrations probably continued to decline as ventilation proceeded.
4. The family had been keeping windows open at least the last 6 months because of warm weather.
5. Urine mercury levels for the mother and father were within a normal range.
6. Urine mercury levels for their 4-year-old boy were slightly elevated, but not at levels of concern.
7. They could not collect urine from their 4-month-old daughter for 24 hours, so the doctors measured blood mercury, which was within a normal range.
8. Blood mercury reflects recent exposure, and urine mercury reflects more long-term exposure.

e. Consequently, it appears that once average airborne concentrations are below 0.010 mg/m^3, ventilation will prevent significant exposure of residents.

7. Our department currently recommends cleaning a home to below 0.010 mg/m^3 before re occupation, and then using ventilation to get rid of the rest of the mercury.

n. According to Dr. Mark McClannahan, formerly ATSDR and now U.S. Centers for Disease Control and Prevention, once the cleanup reduces airborne mercury concentrations in a home to below 0.010 mg/m^3, ventilation is needed. Otherwise, mercury concentrations will not decline as fast as wanted.

o. Ventilate the home for at least two weeks, and then retest it. Again, for meaningful measurements, close windows at least overnight before testing. After a Jerome meter gives zeroes or questionably fluctuating and inconsistent low levels, sample with air pumps and sampling tubes for clearance sampling.

p. Recently, I had a mercury case where a USEPA contractor performed the cleanup. They followed the initial cleanup with ventilation, coupled with electric space heaters to try to bake out the mercury. This baking out was very effective. In two days, the process reduced the average airborne mercury concentration in the home to about the ATSDR guideline. Ventilation alone would have taken about two weeks.

q. Consequently, using electric space heaters can effectively reduce the remediation time and speed the return of a family to their home. This will reduce the stress on them.

n. To recap the cleanup of mercury spills, start with the spill room and any hot spots identified with a Jerome meter.
   1. Use a mercury spill kit or nitric acid (but not both), followed by trisodium phosphate detergent, and then water.
   2. Usually, cleaning to 0.01 mg/m^3, followed by ventilation, is adequate. However, if children or women of child bearing age are present, monitor their urine mercury levels to ensure that overexposure to mercury is not occurring.
   3. After cleaning to below 0.01 mg/m^3, ventilate the home for at least 2 weeks. Using electric space heaters may be able to reduce this ventilation time to a few days. Consequently, I recommend using electric space heaters.
   4. For clearance sampling, use portable air pumps and sampling tubes. This requires laboratory analysis.
   5. If someone in a home has elevated urine mercury levels or is showing symptoms of mercury poisoning, the poisoned person should stay out of the home until ventilation reduces mercury concentrations to the ATSDR guideline. The body slowly eliminates mercury over about a month, so reducing mercury exposure during the recovery period is important.
   6. Cleaning a home to 0.010 mg/m^3 followed by ventilation entails much less inconvenience and property loss for homeowners, and much lower cleanup costs than doing the initial cleanup to the ATSDR guideline. Using electric space heaters speeds the remediation process.

9. To recap mercury and mercury spills,
   a. Mercury spills can result from accidents from stored mercury, breakage of instruments containing mercury, children playing with mercury, or ritualistic uses of mercury.
   b. Mercury absorption is rapid after inhalation, the primary route of concern.
   c. Chronic exposure to mercury can cause neurological and kidney damage, and some of the neurological damage may be permanent.
   d. Children are more sensitive to mercury than adults.
   e. A broken thermometer is a small spill. Clean up visible mercury droplets and ventilate for 2 weeks. Also, avoid vacuuming the contaminated area for 2 weeks.
   f. After a large spill, a family should leave their home. Also, they should get tested for urine mercury levels.
   g. Take measures to minimize the dispersal of mercury. The extent and cost of a cleanup often depend more on the extent of contamination than on the actual amount of mercury spilled.
   h. Never assume that a person, especially a child, who played with mercury is uncontaminated.

i. Use a Jerome meter to map the areas of contamination. Close windows 24 hours, or at least overnight, before all measurements.
j. Start the cleanup in the spill room and any hot spots identified with the Jerome meter.
k. Clean with a mercury spill kit or nitric acid (but not both at once), followed by trisodium phosphate, then water.
l. Ventilate for 2 weeks. Using electric space heaters will shorten this to a few days.
m. Re-test the building.
n. If airborne levels are still too high, clean all the floors and test building contents for contamination.
o. Clean to below 0.010 mg/m3, and then use ventilation to get rid of the rest.
p. Continue the cleanup and ventilation until airborne mercury levels are acceptable.

10. Next, I briefly will describe what USEPA is doing to try to minimize the use of mercury, which will help prevent mercury spills in the first place.
    a. USEPA is urging all industries and schools to eliminate the use of mercury and use alternatives when possible.
    b. The primary reason they are doing this is because of widespread fish contamination because of mercury.
    c. Mercury released from various sources settles into lakes and streams.
    d. There, bacteria convert it into methyl mercury, which is more toxic than elemental mercury and is very bioaccumulative.
    e. They are urging that mercury no longer be used for barometers, blood pressure devices and other medical devices, manometers, thermometers, or thermostats. They also are advocating the replacement of these devices with ones that do not contain mercury.
    f. Not only are alternatives to these mercury-containing available, but the alternatives are just as accurate, and their costs are similar. Consequently, no valid reason exists to continue using mercury-containing devices.
11. What can all of us do to minimize problems with mercury?
    a. We can help educate people.
    b. If your doctor uses mercury-containing blood pressure devices, tell him or her about the hazards of mercury and how expensive a mercury cleanup is. A mercury cleanup of a single small room starts at about $5,000, and costs go up from there. That is particularly true if the mercury gets tracked around or someone decides to use a vacuum cleaner to clean up mercury.
    c. Use non-mercury thermometers and thermostats.
    d. Don't store mercury in your home. It's essentially worthless, but very hazardous and very expensive to clean up.
    e. Overall, I think that public education is the most important thing. Personally, I think that we have a long way to go in that regard.
12. How can we get rid of mercury?

a. The Illinois EPA periodically has household hazardous waste pickup days, where you can take mercury.
b. In addition, the Naperville Recycling Center will accept mercury.

13. Are there any questions?